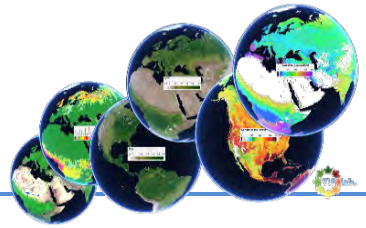

MODIS & VIIRS Vegetation Index Suite Focus Continuity

Terra, Aqua, S-NPP Land Virtual Workshop – June 30 - July 1, 2020

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[1]**University of Arizona**

vip.arizona.edu

VIP Lab. vegetation index & phenology Lab.

...Understanding a piece of the Earth system

NASA THE UNIVERSITY OF ARIZONA. Institute of the Environment USA npn National Phenology Network USGS LP DAAC

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VI Time Series Status and Immediate Plans

MODIS VI Suite (in its +20th year)

Collection 5: (Suspended in 2018)
Collection 6: (Released in 2015)
Collection 7: (In prep)

Status and Updates:

- Improved QA compositing scheme
- Multiple and ongoing algorithm adjustments to deal with changes in upstream products and data issues
- Ongoing opportunistic validation (using NEON data)

Known Issues:

- The 2010 (C6) decision to use pre-composited 8-day surface reflectance inputs is causing spatial consistency issues that will be addressed in C6.1/C7
- LW Mask continues to be a nuisance

VIIRS VI Product Collection 1

Collection 1: (Released in 2018): Consistent with MODIS
Collection 2: (In prep)

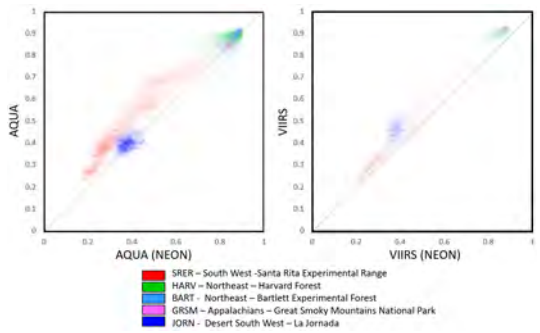
Status and Updates:

- Solid QA-driven compositing approach adopted from the MODIS C5 Science Algorithm and based on daily inputs
- The full VIIRS time series is regularly compared to MODIS Aqua (Terra)
- Time series fully characterized with explicit MODIS T/A continuity transfer functions & opportunistic validation with NEON

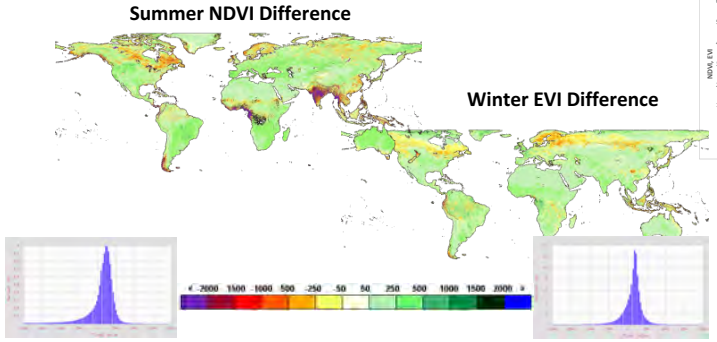
Known Issues:

- Algorithm/Product suite orphaned and no longer supported (post A.37) while the PI/SCF continues to support the Algorithm & time series due to its critical value to the science community (there are thousands of users and tens of global agencies and private companies that depend on our effort and continued support).

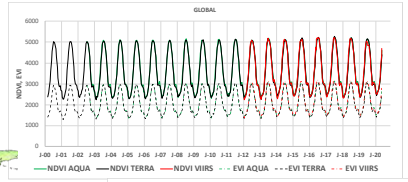
Aqua and S-NPP VIIRS NDVI/EVI Time Series Opportunistic Validation with NEON Data. Strong VIIRS Performance

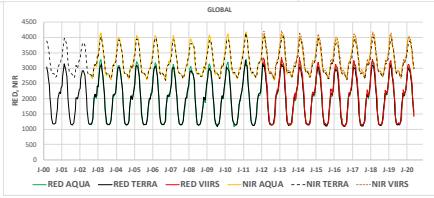


VIIRS – Aqua MODIS Difference



Long Term VI & LSR Suite (Terra/Aqua MODIS and VIIRS





Future plans

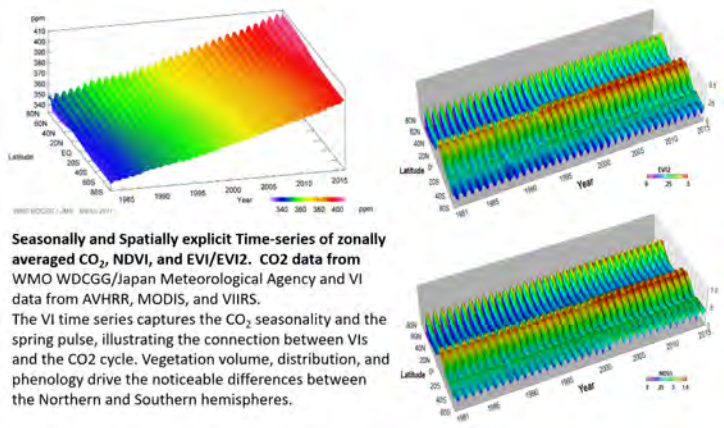
- A robust and Internal LW mask to avoid current problems (near shorelines) • Internal cloud mask and finer resolution • Still exploring a 375 m (requested by key VI users) from VIIRS. Updated Long-term CMG databases • Back to daily for MODIS and Prototyping an experimental **ZERO CLOUD** product suite with Gap filling • Aiming at Validation Stage 4 for MODIS and 2/3 for VIIRS.

Vegetation Index (VI) time series from MODIS and Suomi-NPP are quasi-identical, with a correlation R^2 > ~96% with minor differences (NDVI = ± 2% and EVI = ± 1.7%) and standard deviation (a measure of the TS continuity error) of ~ 0.057 (NDVI) and 0.0386 (EVI). Spatially and Seasonally explicit continuity transfer function are the major goal of our effort.

Carbon, VI Continuity, & Long-Term Plans

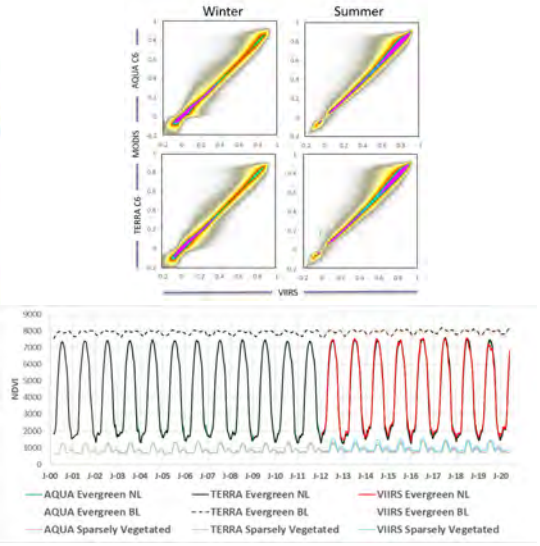
THE UNIVERSITY OF ARIZONA.

Carbon Cycle & VI Time Series

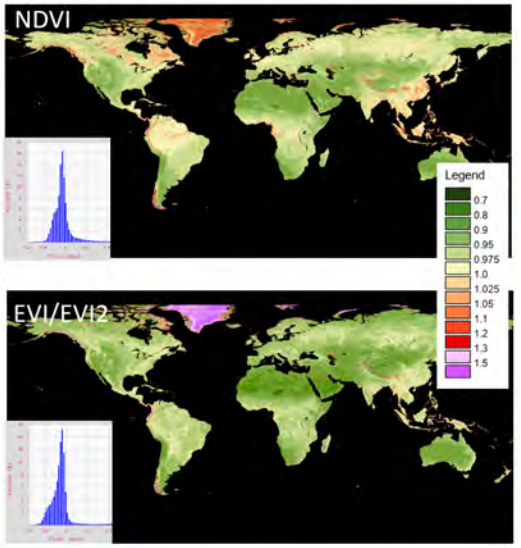


Seasonally and Spatially explicit Time-series of zonally averaged CO_2, NDVI, and EVI/EVI2. CO2 data from WMO WDCGG/Japan Meteorological Agency and VI data from AVHRR, MODIS, and VIIRS.
The VI time series captures the CO_2 seasonality and the spring pulse, illustrating the connection between VIs and the CO2 cycle. Vegetation volume, distribution, and phenology drive the noticeable differences between the Northern and Southern hemispheres.

S-NPP VIIRS & MODIS Continuity

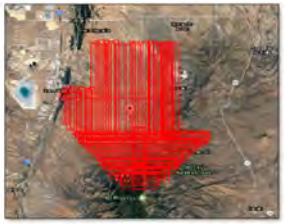


S-NPP VIIRS & MODIS Transfer Functions

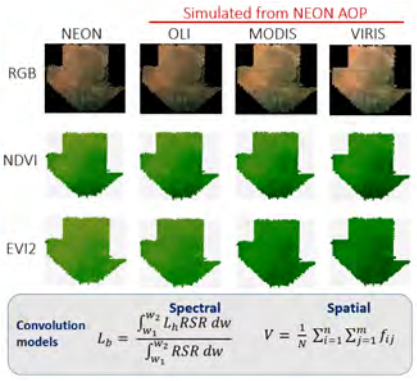


Online platform for VI Validation and Across sensor continuity

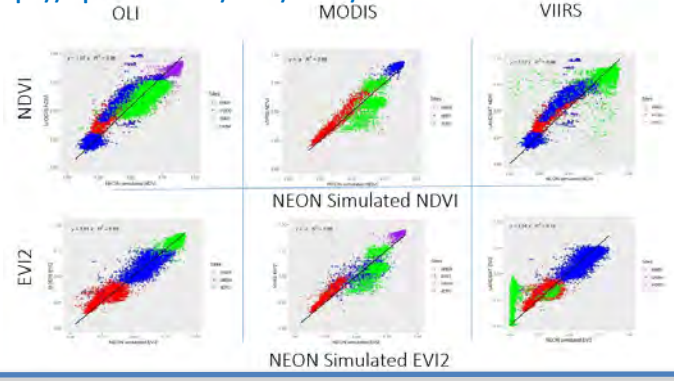
https://vip.arizona.edu/tools/NEON/



NEON flight lines (2017/2018/2019, 1 m hyperspectral).
Santa Rita Experimental Range (SRER, Tucson, AZ)



$$L_b = \frac{\int_{w_1}^{w_2} L_h RSR\, dw}{\int_{w_1}^{w_2} RSR\, dw} \qquad V = \frac{1}{N}\sum_{i=1}^{n}\sum_{j=1}^{m} f_{ij}$$



VIIRS	r^2	Std Error	Slope	Std Error	t Stat	Lower 95%	Upper 95%
NDVI SRER	0.9905	0.04461	1.07491	0.00236	454.640	1.07029	1.07957
EVI2	0.9843	0.03654	1.17492	0.00311	377.892	1.16883	1.18102
RED	0.9676	0.01368	1.04936	0.00268	397.435	1.04418	1.05454
NIR	0.9915	-0.03011	1.14130	0.00237	481.570	1.13665	1.14595
NDVI JORN	0.9804	0.05043	1.36308	0.00534	255.123	1.35260	1.37356
EVI2	0.9828	0.03307	1.26085	0.00462	272.877	1.25179	1.26992
RED	0.9830	0.01997	0.71848	0.00262	274.169	0.71334	0.72362
NIR	0.9942	-0.02446	0.89738	0.00190	473.201	0.89366	0.90110
NDVI HARV	0.8212	-0.28500	0.72835	0.00781	93.277	0.71303	0.74366
EVI2	0.8540	-0.17103	0.72745	0.00691	105.289	0.71396	0.74100
RED	0.4364	0.13231	4.00071	0.10579	37.813	3.84331	4.25811
NIR	0.9198	0.10999	1.05999	0.00719	147.394	1.04589	1.07410
NDVI GRSM	0.9988	0.03160	1.05798	0.00099	1065.428	1.05604	1.05992
EVI2	0.9726	0.09696	0.90043	0.00807	221.093	0.89242	0.90840
RED	0.9067	0.00502	0.47158	0.00427	111.749	0.46878	0.48554
NIR	0.9486	0.07862	0.81341	0.00510	159.368	0.80340	0.82342
NDVI BART	0.996579	0.052575	1.049047	0.002198	477.2906	1.0447123	1.0533614
EVI2	0.970604	0.098383	0.978422	0.006068	161.2535	0.9665113	0.9903327
RED	0.515178	0.018215	0.60199	0.022667	26.55944	0.5694554	0.6935253
NIR	0.952707	0.073868	0.914173	0.007284	125.5115	0.8996751	0.9284794

Recent Publications:

- Jarchow CJ, Waugh WJ, Didan K, Barreto-Muñoz A, Herrmann S, Nagler PL. Vegetation-groundwater dynamics at a former uranium mill site following invasion of a biocontrol agent: A time series analysis of Landsat normalized difference vegetation index data. Hydrological Processes. 2020, Apr 29.
- Nouri H, Nagler P, Chavoshi Borujeni S, Barreto Munez A, Alaghmand S, Noori B, Galindo A, Didan K. Effect of Spatial Resolution of Satellite Images on Estimating the Greenness and Evapotranspiration of Urban Green Spaces. Hydrological Processes.(. 2020, Apr 29.).
- Xian Wang, Dong Yan 1, Matthew P. Dannenberg, Matthew O. Jones, John S. Kimball, David J.P. Moore, Willem J. D. van Leeuwen, Kamel Didan, William K. Smith. 2019. Comparisons of global land surface phenology derived from vegetation greenness, optical depth, and solar-induced chlorophyll fluorescence. Journal of Geophysical Research - Biogeosciences 2020 (in press).